WPI
Solutions for Government and Industry

WPI – Richmond Office
11 S. 12th St., Ste 210
Richmond, VA 23219
Tel: (804) 783-0183
Fax: (804) 783-0185

November 9, 2005

Erhard Koehler
Senior Technical Advisor, NS SAVANNAH Project
US Maritime Administration
Department of Transportation
400 Seventh Street S.W., MAR 610-2119
Washington, DC 20590

Subject: NS SAVANNAH Characterization Project

Dear Mr. Koehler,

This transmittal provides MARAD the following document for their review and acceptance.

1. NS SAVANNAH Primary and Secondary Systems Water Level Determination, Revision 0, dated June 15, 2005

The summary results for the water level determination are as follows:

Reactor Vessel bottom head:	734.3 gallons
Cold legs (port & stbd) piping:	142.6 gallons
Port Steam Generator	138.8 gallons
Starboard Steam Generator	354.2 gallons
Hot leg (stbd) piping	65.9 gallons
Total Water Volume	1435.8 gallons

If you have any questions do not hesitate to contact me at (804) 239-7158.

Sincerely,

John W. Millacci

John W. Millacci, P.E.
Director of Energy Projects

Solutions for Government and Industry

WPI – Richmond Office
11 S. 12th St., Ste 210
Richmond, VA 23219
Tel: (804) 783-0183
Fax: (804) 783-0185

Cc:
F. Fitzgerald w/attachment
G. Solovey w/attachment
J. Wiegand w/attachment

WPI

Operating Procedure

NSS-PRO-020

N/S SAVANNAH Primary and Secondary Systems Water Level Determination

REVISION 0

Prepared by: _______________ Date: June 15, 2005

Approved by: _______________ Date: June 15, 2005

MARAD Approval: _______________ Date: June 16, 2005

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1.0 PURPOSE

This procedure provides instructions for the determination of water level in the N/S SAVANNAH reactor pressure vessel (RPV), primary piping system and steam generators (both primary and secondary sides). After the current water levels are established in the various components, approximate water volumes will be calculated.

The following is a synopsis of the results from the pre-job walk down that was performed on June 1 and 2, 2005 for water level determination in the N/S SAVANNAH RPV, primary piping and steam generators (both primary sides).

As-Found Conditions:

1. Both primary loop cold leg isolation valves (PS-4V & PS-6V) were found in the open condition.
2. The forward primary loop hot leg isolation valve (PS-5V) for the starboard steam generator was found in the open condition.
3. The aft primary loop hot leg isolation valve (PS-3V) for the port steam generator was found in the closed condition.
4. Information from the characterization effort; water was noted in both the starboard and port primary side steam generators. Based on initial observations, approximately 1/2 of the tube sheet in the starboard steam generator and 1/3 of the tube sheet in the port steam generator was covered with water. These water levels will be refined during the execution of this procedure. The difference in levels may be attributable to a slight starboard and aft list of the N/S SAVANNAH.

2.0 REFERENCES

2.1 Title 10, Code of Federal Regulations, Part 20

2.2 N.S. Savannah Health Physics Manual

2.3 NSS-100, Radiation Worker Training

2.4 NSS-110, Dosimetry Issue

2.5 NSS-130, Contamination Control

2.6 NSS-140, Radiation Surveys and Sampling

2.7 NSS-150, Radioactive Airborne Sampling

2.8 NSS-160, Managing Respirators

2.9 NSS-200, Shipboard Radwaste Management

2.10 NSS-300, Data and Record Management

2.11 Drawing RC-04-J-535, N.S. SAVANNAH Engineering Flow Diagram for the Primary & Auxiliary Systems

2.12 PD-31J-396, N.S. SAVANNAH Equipment Drain & Waste Collection System

2.13 Final Safeguards Report, Volume I, Figure 3.4-3; Primary and Auxiliary Systems

3.0 RESPONSIBILITIES

NOTE: All reference to the Radiation Safety Officer (RSO) in the procedure applies to the RSO or designee.

3.1 The RSO is responsible for ensuring the requirements of the N/S Savannah Health Physics Manual are being implemented.

3.2 Radiation workers are responsible for complying with the requirements of this Procedure, the N/S Savannah Health Physics Manual and its implementing procedures.

4.0 PREREQUISITES

4.1 All work will be performed under an active RWP.

4.2 Protective clothing, respiratory protection and dosimetry will be as per the RWP.

4.3 A Marine Chemist has determined that the Containment Vessel (CV) atmosphere is acceptable for personnel entry.

4.4 All personnel involved will be trained as per the WPI training requirements and the N/S Savannah Health Physics Manual.

4.5 Fire protection equipment (fire extinguishers) is placed in the CV.

5.0 PRECAUTIONS AND LIMITATIONS

5.1 Extreme care, due to potential high contamination levels of primary water and crud on primary system internal surfaces, is to be taken whenever primary systems are open.

5.2 Air monitoring shall be performed per the direction of the RSO whenever primary systems are breached.

5.3 The steam generator secondary side water levels will be determined prior to water level determination in the primary systems. Once the steam generator secondary side water level is determined, that secondary side will be sealed.

5.4 No piping insulation is to be removed during this effort. Insulation covers on manway inspection ports may be removed once the insulation has been wetted with a misting water spray.

5.5 All primary and secondary water is considered to be contaminated. Upon disconnection of the clear tubing, all water in the tube will be captured in a plastic bag or equivalent or returned to only the primary side of either steam generator (a small amount of secondary water may be saved from each steam generator secondary side, as available, for analysis).

6.0 PROCEDURE

GENERAL NOTES

1. STEPS THAT DOCUMENT THE WATER VOLUME CALCULATIONS MAY BE PERFORMED AT ANY TIME AFTER THE APPLICABLE WATER LEVELS ARE DETERMINED.

2. THE LOWER 2 TO 3 INCH LEAD SHIELDING TRANSITION LINE ON THE OUTSIDE OF THE NEUTRON SHIELD TANK WILL BE USED AS THE ZERO REFERENCE FOR WATER LEVEL MEASUREMENTS.

Steps 6.1 and 6.2 may be performed in any order.

6.1 WATER LEVEL DETERMINATION: PORT SIDE STEAM GENERATOR SECONDARY SIDE.

JWB 6.1.1 Remove the insulation cover on the steam drum manway inspection port.

JWB 6.1.2 Undo the bolts and open the steam drum manway inspection port. This will provide the high vent for determining the water level in the secondary side of the steam generator.

JWB 6.1.3 Locate and determine the most accessible valve sets per Exhibit 1 (trace the lines back to the secondary side of the steam generator and verify that these are attached to the secondary side of the steam generator – the valve numbers may be changed in step 6.1.3, step 6.1.4 and Appendix B via initial and date to reflect the appropriate secondary side steam generator drain valves):

6.1.3.1 PD-1V and PD-2V or

~~6.1.3.2 PD-3V and PD-4V~~ No – VLVS for primary SIDE DRNS JWB JWB *

JWB 6.1.4 Locate an accessible area on the drain line ~~and install a hot tap valve~~ on the outboard side of the either PD-2V or PD-4V.

JWB 6.1.5 Install clear tubing to the ~~hot tap and open the hot tap isolation valve~~ ACCESSIBLE AREA JWB*

JWB 6.1.6 Open the 2 isolation valves identified in step 6.1.3.1 or 6.1.3.2 to allow any secondary water to flow into the tubing attached in step 6.1.5.

JWB 6.1.7 Determine the secondary water level in the steam generator by reference leg measurement

JWB 6.1.8 Close the 2 isolation valves opened in step 6.1.6 JWB*

6.1.9 ~~Close the hot tap isolation valve opened in step 6.1.5 and~~ disconnect the tubing (refer to Precaution and Limitation item 5.5)

JWB 6.1.10 Close and bolt the steam drum manway inspection port.

6.1.11 Calculate the water volume in the steam generator secondary side

* Approved via telecon by Koehler & Stacey on 6/23/05 JWB 6/23/05

Secondary water level to bottom of Port Stm gen. WTR LVL was 28½ inches above the 2" to 3" LEAD shielding interface. JWB

Secondary WTR LVL to bottom of STBD STM generator - WTR LVL WAS 30½" Above the 2" to 3" LEAD shielding interface JWB

6.2 WATER LEVEL DETERMINATION: STARBOARD SIDE STEAM GENERATOR SECONDARY SIDE.

JWB 6.2.1 Remove the insulation cover on the steam drum manway inspection port.

JWB 6.2.2 Undo the bolts and open the steam drum manway inspection port. This will provide the high vent for determining the water level in the secondary side of the steam generator.

JWB 6.2.3 Locate and determine the most accessible valve sets per Exhibit 1 (trace the lines back to the secondary side of the steam generator and verify that these are attached to the secondary side of the steam generator – the valve numbers may be changed in step 6.2.3, step 6.2.4 and Appendix B via initial and date to reflect the appropriate secondary side steam generator drain valves):

~~6.2.3.1 PD-14V and PD-15V or~~ NO - VLVS for primary SIDE DRN JWB *

6.2.3.2 PD-16V and PD-17V

JWB 6.2.4 Locate an accessible area on the drain line ~~and install a hot tap valve~~ on the outboard side of the either PD-15V or PD-17V JWB *

JWB 6.2.5 Install clear tubing to the ACCESSIBLE AREA ~~hot tap and open the hot tap isolation valve~~

JWB 6.2.6 Open the 2 isolation valves identified in step 6.2.3.1 or 6.2.3.2 to allow any secondary water to flow into the tubing attached in step 6.2.5.

JWB 6.2.7 Determine the secondary water level in the steam generator by the reference leg measurement

JWB 6.2.8 Close the 2 isolation valves opened in step 6.2.6 JWB *

JWB 6.2.9 ~~Close the hot tap isolation valve opened in step 6.2.5 and~~ disconnect the tubing (refer to Precaution and Limitation item 5.5)

JWB 6.2.10 Close and bolt the steam drum manway inspection port.

6.2.11 Calculate the water volume in the steam generator secondary side

Steps 6.3, 6.4 and 6.5 may be performed in any order.

* Changes approved via telecom by Stoury & Koehler on 6/23/05 JWB 6/23/05

6.3 WATER LEVEL DETERMINATION: RPV AND BOTH PRIMARY LOOP COLD LEGS

The primary high point vent will be provided by the pressure tap originating at approximately mid-plane of the hot leg nozzle on the forward primary loop hot leg going to the starboard steam generator that was used to determine loop pressure during operation. For contingency planning purposes (alternatives); the high point vent could also be the CRD seal water leak-off line or RPV "O" ring leakage sensing line. Both cold leg loop isolation valves, PS-4V (port) and PS-6V (stbd), are in the open position.

JWB 6.3.1 The high pressure tap is determined by the following process (trace the piping from the hot leg to the manifold). The pressure tap for the high point vent is piped from a pressure tap originating at approximately mid-plane of the hot leg nozzle on the forward primary loop hot leg to a manifold located on the 4th level in the CV on the starboard side under the steam generator. The manifold has an open pipe fitting (covered and taped via a clear bag containing rags) that is isolated from the system by 2 isolation valves (their valve numbers will be established as HL-1V and HL-2V per Exhibit 2).

JWB 6.3.1.1 Open isolation valves HL-1V and HL-2V going to the open pipe fitting. The high point vent is established.

JWB 6.3.2 The primary low point water level tap will be provided by the primary loop cold leg drain line originating on the aft primary loop cold leg for the port steam generator. A hot-tap valve will be installed on the drain line outboard of the both drain line isolation valves (their valve numbers will be established as PD-9-1 and PD-9-2 per Exhibit 2). The insulation has already been removed from the section of drain line where the hot-tap valve is planned to be installed.

JWB 6.3.2.1 Locate an accessible area on the drain line and install a hot tap valve on the outboard side of the either PD-9-2

JWB 6.3.2.2 Install clear tubing to the hot tap and open the hot tap isolation valve

JWB 6.3.2.3 Open the 2 isolation valves identified as PD-9-1 and PD-9-2 to allow any primary water to flow into the tubing

JWB 6.3.2.4 Determine the primary water level in both cold legs and the RPV by the reference leg measurement

JWB 6.3.2.5 Close the 2 isolation valves identified as PD-9-1 and PD-9-2

JWB 6.3.2.6 Close the hot tap isolation valve opened in step 6.3.2.2 and disconnect the tubing (refer to Precaution and Limitation item 5.5)

JWB 6.3.2.7 Close isolation valves HL-1V and HL-2V going to the open pipe fitting.

6.3.3 Using the water level determined in step 6.3.2, calculate the water volumes for:

6.3.3.1 RPV

6.3.3.2 Primary loop cold leg (Forward) going to starboard steam generator

6.3.3.3 Primary loop cold leg (Aft) going to port steam generator

HOT TAP WAS INSTALLED. APPROX. 2/3 OF COLD leg (inlet) WAS covered / full OF WTR. WTR LVL WAS 51 1/2" below the 2" to 3" interface OF the LEAD SHIELDING JWB

6.4 WATER LEVEL DETERMINATION: PRIMARY HOT LEG TO PORT SIDE STEAM GENERATOR

The water level of interest would be from the aft hot leg nozzle to the port side primary loop hot leg isolation valve (PS-3V) per Exhibit 2. This effort includes determination of the water level in the piping going to the letdown coolers (non-regenerative and regenerative heat exchangers) and the short leg of piping prior to the 2 isolation valves (DK-26V and DK-21V) going to the emergency canned pump since they are connected to the bottom of the hot leg upstream of the port side primary loop hot leg isolation valve (PS-3V). As noted in Section 1 above, the aft primary loop hot leg isolation valve (PS-3V) for the port steam generator was found in the closed condition and an existing instrument tap that could be used as a low point water level tap could not be found on the piping going to the letdown coolers.

JWB 6.4.1 Close or verify closed isolation valves (DK-26V and DK-21V) going to the emergency canned pump

JWB 6.4.2 Remove the inspection manway on the primary inlet port side steam generator that was removed during the characterization effort (the insulation cover for the inspection manway may need to be removed – refer to Precautions and Limitations item 5.4).

JWB 6.4.3 Perform an accurate water level measurement in the primary side inlet of the port steam generator.

JWB 6.4.4 Slowly open the port side primary loop hot leg isolation valve (PS-3V) to allow the water to equalize on both sides of the valve. **PS-3V will be left in the open position**

6.4.4.1 If water level upstream of the port side primary loop hot leg isolation valve (PS-3V) is higher than the water level in the port steam generator, water will flow into the steam generator.

WTR LVL in STM gen. primary SIDE did not change JWB

6.4.4.2 If water level upstream of the port side primary loop hot leg isolation valve (PS-3V) is lower (or the pipe is void of water) than the water level in the port steam generator, water will flow into the hot leg pipe and potentially into the piping going to the letdown coolers.

6.4.4.3 If water level upstream of the port side primary loop hot leg isolation valve (PS-3V) is equal to the water level in the port steam generator (e.g. water has leaked by the valve seat over the last 30 years and established equilibrium), water level in the steam generator would not change.

JWB 6.4.5 Once water level has reached equilibrium, Re-measure the water level (similar as in step 6.4.3 above) in the primary side of the port steam generator.

no change in level JWB - Hot leg pipe is empty.

JWB 6.4.6 Re-Install the inspection manway on the primary inlet port side steam generator

6.4.7 Using the water level determined in step 6.4.5, calculate the water volumes for:

6.4.7.1 Primary hot leg (aft) to port side exchanger

6.4.7.2 Port side steam generator

6.4.7.3 Piping going to the letdown coolers

6.5 WATER LEVEL DETERMINATION: PRIMARY HOT LEG TO STARBOARD SIDE STEAM GENERATOR

The water level of interest would be from the forward hot leg nozzle to the starboard side primary loop hot leg isolation valve. This effort includes determination of the water level in the pressurizer surge line since it is welded at the mid-plane to the side of the hot leg upstream of the starboard side primary loop hot leg isolation valve. As noted in Section 1 above, the forward primary loop hot leg isolation valve (PS-5V) for the starboard steam generator was found in the open condition per Exhibit 2.

JWB 6.5.1 Remove the inspection manway on the primary inlet starboard side steam generator that was removed during the characterization effort (the insulation cover for the inspection manway may need to be removed – refer to Precautions and Limitations item 5.4).

JWB 6.5.2 Perform an accurate water level measurement in the primary side inlet of the starboard steam generator.

JWB 6.5.3 Re-Install the inspection manway on the primary inlet starboard side steam generator

6.5.4 Using the water level determined in step 6.5.2, calculate the water volumes for:

6.5.4.1 Primary hot leg (forward) to starboard side steam generator

6.5.4.2 Starboard side steam generator

6.5.4.3 Pressurizer surge line

6.6 SYSTEM RESTORATION CHECKLIST

6.6.1 Document the as-left valve positions in Appendix B

7.0 RECORDS

7.1 All calculations will be reviewed by an individual who did not perform the calculations.

7.2 All calculations will be documented on Appendix A of this procedure. Multiple pages of Appendix A may be used and attached to the completed procedure.

Exhibit 1 – Secondary Water Level Determination Layout

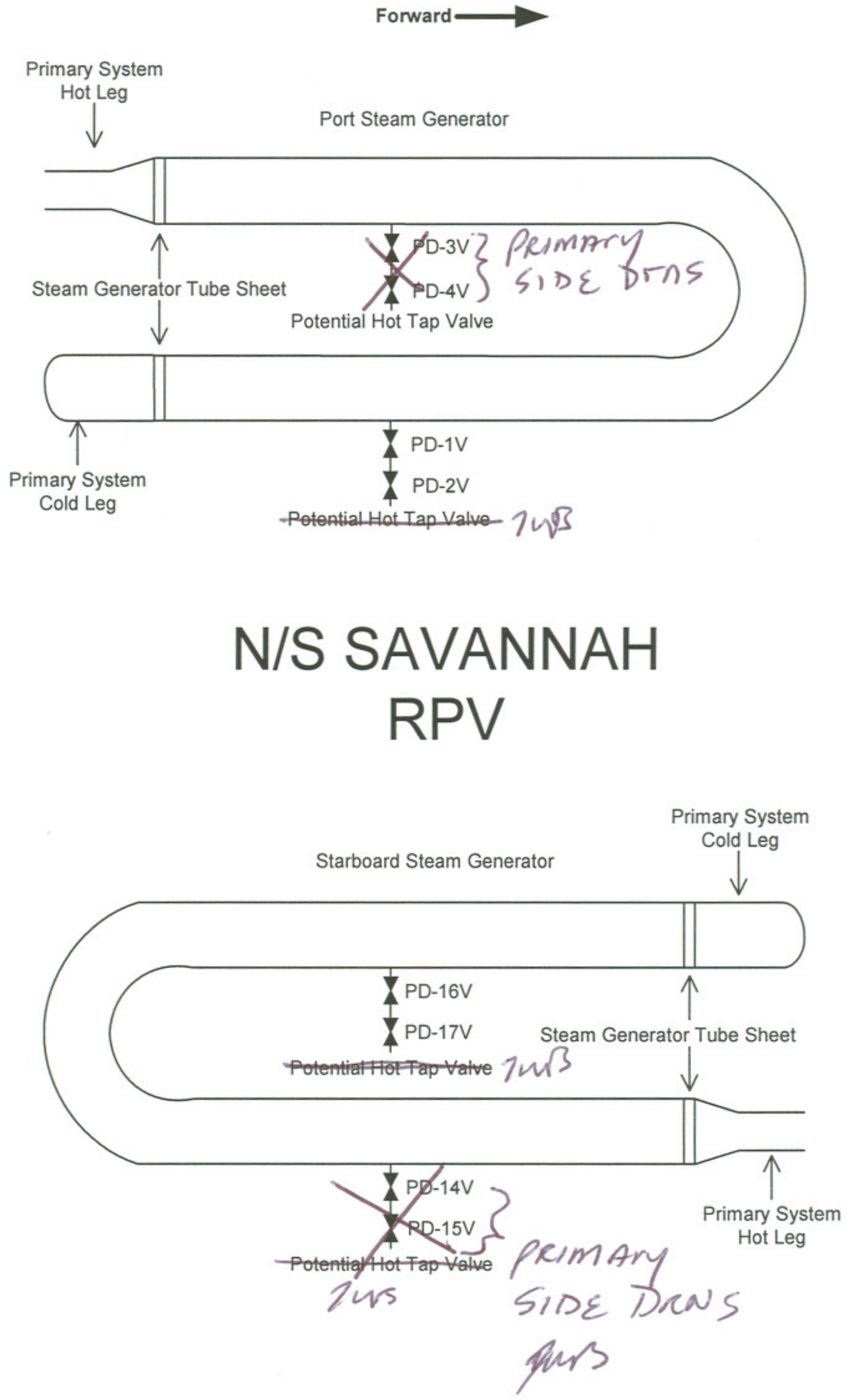
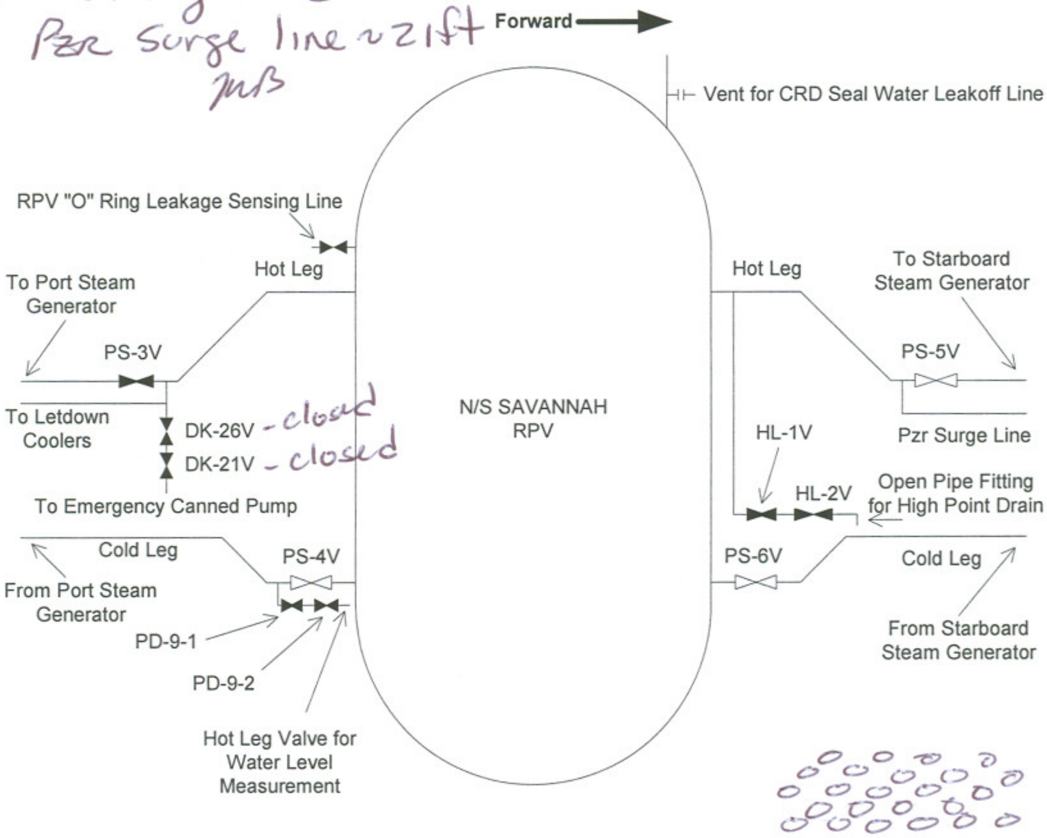


Exhibit 2 – Primary Water Level Determination Layout

MB
~~STM~~ Hot Leg ~ 28ft
Pzr Surge line ~ 21ft
MB



Front of tube sheet

Port Stm Gen. Primary Side: WTR Level covered 3 1/2 tubes on tube sheet vertical or 6 1/2 total tubes. WTL Level is approx. 2" below lower Access (inspection manway) penetration. The hot Leg AFT/Port Side is dry/empty

STBD STM Gen Primary Side: WTR level covered 6 tubes on the tube sheet vertical or 12 total tubes. WTR Level ~~is~~ in the inlet (Hot Leg) pipe is approx. 1/3 up from bottom (1/3 filled with WTR) (Hot Leg Foward - STBD is 1/3 filled w/ WATER)

Appendix A – Calculations

RV Bottom Head WTR Calculation:

- Radius of spherical bottom head: 49 7/64"
(Ref. N.S. Savannah Reactor Construction and Design Calculations)

- Volume of a spherical cap of radius r & height h

$r = 49.109''$

$h = 49.109'' - 10.5''$

$h = 38.609''$

$$\text{Volume} = \frac{1}{3}\pi h^2 (3r - h)$$

$$= \frac{1}{3}\pi (38.609'')^2 (3 \cdot 49.109'' - 38.609'')$$

$$= \frac{1}{3}\pi (1490.6548)(147.327 - 38.609)$$

$$= 169{,}623.84 \text{ in}^3 = 98.162 \text{ ft}^3$$

Density of water $= \rho = 8.329$ lb/gal @ 70°F

Specific volume of water $= v = 0.01605$ ft³/lb @ 70°F

Calculations performed by/date: [signature] 6/27/05

Calculations reviewed by/date: John Millar 11.7.05

Appendix A – Calculations

Volume of water in bottom head:

$$\text{Volume} = (98.162\ ft^3)\left(\frac{lb}{0.01605\ ft^3}\right)\left(\frac{gal}{8.329\ lb}\right)$$

Water Volume = 734.3 gal (RV Bottom Head)

Water volume in cold legs:

$$\%\ \text{Volume of Pipe filled} = \frac{10.8125''}{12.625''} = 85.64\%$$

$$\text{Volume of cylinder} = \pi r^2 h$$

$$r = 6.3125'' \ ;\ h = 2.6' + 3.9' + 2.8' + 2' + 1.5'$$

$$h = 12.8'$$

$$\text{Volume} = \pi (0.526\ ft.)^2 (12.8\ ft)$$
$$= 11.12\ ft^3$$

$$\text{Water volume per cold leg} = (11.12\ ft^3)\left(\frac{lb}{.01605\ ft^3}\right)\left(\frac{gal}{8.329\ lb}\right)$$
$$= 83.2\ gal\ /\ 1\ leg\ @\ 85.64\%$$
$$= 71.3\ gal$$

Total volume in RV bottom head & both cold legs

$$= 734.3\ gal + 2 \cdot \cancel{83.2}^{\text{JWB}}\ gal = \cancel{900.7}^{\text{JWB}}\ gal$$
$$71.3\ gal = \underline{876.9\ gal}$$

$$\boxed{= 876.9\ gal}$$

Calculations performed by/date: J. W. B. 6/27/05

Calculations reviewed by/date: John Millacci 11/7/05

Appendix A – Calculations

Dimensions from Drwg 40784E from Steam Generator Instruction Book, B+W, 2/59

S/G (Port) $\text{area}_{WTR} = \text{Area}_A + \text{Area}_B + \text{Area}_{TUBING}$

where:

Area A = right spherical + cylindrical end

Area B = left spherical + cylindrical end

Area_{TUBING} = Area of tubing filled w/ water

$$\text{Volume } A = \frac{1}{3}\pi h^2(3r-h) + \pi r^2 h$$

$$= \frac{1}{3}\pi(36'')^2(3(18)-36'') + \pi(17.5'')^2(13'')$$

$$= \left[\frac{\pi}{3}(1296)(18)\right] + \left[\pi(306.25)(13)\right]$$

$$= 24{,}404.6 \text{ in}^3 + 12507.5 \text{ in}^3$$

$$= 36{,}912.1 \text{ in}^3 / 1728 \frac{\text{in}^3}{\text{ft}^3}$$

$$= 21.36 \text{ ft}^3$$

Calculations performed by/date: [signature] 11/7/05
Calculations reviewed by/date: [signature] 11/8/05

Appendix A – Calculations

$$\text{Volume } B = \tfrac{1}{3}\pi\,(36'')^2(3(18)-36) + \pi(18)^2(45.25)$$

$$= 24{,}404.6\ in^3 + 46{,}058.9\ in^3$$

$$= 70{,}462.9\ in^3 / 1728\ \tfrac{in^3}{ft^3} = 40.77\ ft^3$$

$$\therefore\ V_A + V_B = 40.77\ ft^3 + 21.36\ ft^3$$

$$= 62.13\ ft^3$$

where as: Water level covers 6 tube layers, this covers 129 of 812 tubes = 15.89%
therefore water volume = 15.89% of total volume of Area A & B + Volume of 129 tubes

$$V_{TOT} = .15(62.13\ ft^3) + V_{129t}$$

$$= (62.13)(.1589) + V_{129t}$$

$$= 9.87\ ft^3 + V_{129t}$$

Calculations performed by/date: [signature] 11.7.05
Calculations reviewed by/date: [signature] 4/8/05

Appendix A – Calculations

Tubing Volume: Assume average arc length of 7'10" which is the average length of arcs between and inclusive of T-16 to T-46 (Dwg. 66578E-3)

Tube pipe length = $9'6\frac{3}{8}" + 9'6\frac{3}{8}" + 7'10" = 322.75"$

$\therefore\ h = 322.75"$ $r = (.75" - .072")/2 = .339"$

$V_{TUBE} = \pi r^2 h = \pi(.339)^2(322.75)$

$= 116.52\ in^3 / 1728\ \frac{in^3}{ft^3}$

$= .0674\ ft^3$

$V_{129t} = 129 \times .0674\ ft^3$

$= 8.69\ ft^3$

Calculations performed by/date: John Mellacin 11.7.05
Calculations reviewed by/date: [signature] 11/07/05

Appendix A – Calculations

Volume water Port S/G

$= 9.87 ft^3 + 8.69 ft^3$

$= 18.56 ft^3$

$\rho_{H2O} = 8.329\ lb/GAL\ @\ 70°F$

$V_{H_2O} = .01605\ ft^3/lb\ @\ 70°F$

$$\text{Water Volume} = 18.56 ft^3 \left(\frac{Lb}{.01605 ft^3}\right)\left(\frac{gal}{8.329\ lb}\right)$$

$= 138.8\ gal$

Calculations performed by/date: [signature] 11.7.05
Calculations reviewed by/date: [signature] 11/08/05

Appendix A – Calculations

Starboard S/G

$$\text{Volume Total} = (62.13\,ft^3)(x) + V_{\text{FILLED TUBES}}$$

Water level covered 12 tube layers

Therefore 329 of 812 tubes were filled

$$\therefore\ x = 329/812 = 40.52\,\%$$

$$V_{wtr} = (62.13\,ft^3)(.4052) + V_{329t}$$

$$= 25.18\,ft^3 + V_{329t}$$

$$V_{329t} = 329\,(.0674\,ft^3) = 22.17\,ft^3$$

$$V_T = 25.18\,ft^3 + 22.17\,ft^3 = 47.35\,ft^3$$

$$V_{\substack{\text{STBD S/G}\\ \text{WATER}}} = (47.35\,ft^3)\left(\frac{lb}{.01605\,ft^3}\right)\left(\frac{gal}{8.329\,lb}\right)$$

$$= 354.2\ gal$$

Calculations performed by/date: John [signature] 11.7.05

Calculations reviewed by/date: [signature] 11/8/05

Appendix A – Calculations

Piping Volume - Hot leg forward - Stbd

Piping is $\frac{1}{3}$ filled = 33 %

Pipe length: From page C-7 of NSS Primary Piping Design Calculations, B+W 5/13/59

$12\frac{5}{8}$" ID = [.833 + 3.706 + 3.924 + 3.079 + 3.14 + 2.965 + .63 + 3.14 + 5.885 + 1.57] ft

= 28.872 ft   Arc length = $\frac{\pi d}{4} = \frac{\pi 4}{4} = 3.14$ ~~ft~~ [illegible]

4" Sch 160 piping ≅ 3.5" ID

3.5" length = [2.833 + .785 + 9.0 + .785 + 3.687 + .785 + 2.151 + .3925] ft

= 20.42'   Arc length = $\frac{\pi d}{4} = \frac{\pi \cdot 1}{4} = .785$

Water Volume in hot leg

$V_{cyl.} = \pi r^2 h$ where $r_1 = 12\frac{5}{8}/2 = 6.3125" = .526'$

$= \pi(.526)^2(28.872)$ $h_1 = 28.872'$

$= 25.096\ ft^3$

Calculations performed by/date: [signature] 11.4.05

Calculations reviewed by/date: [signature] 11/08/05

Appendix A – Calculations

$V_{cyl_2} = \pi r_2^2 h_2^2$ where $r_2 = 3.5/2 = 1.75'' = .1458'$

$h_2 = 20.42'$

$= \pi (.1458)^2 (20.42)$

$= 1.364 \ ft^3$

$V_{TOT} = 25.096 + 1.364 = 26.46 \ ft^3$

Water Volume $= (26.46 ft^3)\left(\frac{lb}{.01605 ft^3}\right)\left(\frac{gal}{8.329 \ lb}\right)$

$= 197.9 \ gal \times .333$

$= 65.9$ gal in hot leg

Calculations performed by/date: John McNulty 11.4.05

Calculations reviewed by/date: [signature] 11/08/05

Appendix A – Calculations

Total Water Volume =

$$V_{RV\ BOTTOM\ HEAD} + V_{COLD\ LEGS} + V_{PORT\ S/G} + V_{STBD\ S/G} + V_{HOT\ LEGS}$$

$$= 734.3g + 142.6g + 138.8g + 354.2g + 65.9g$$

$$= 1435.8 \text{ gallons}$$

Calculations performed by/date: [signature] 11/7/05
Calculations reviewed by/date: [signature] 11/08/05

Appendix B – Final Valve Positions

Document the as-left valve positions for the following valves (desired valve positions are annotated in parentheses). As left positions may be documented any time after the applicable section relating to that valve is completed.

Item	Valve Number	Valve Name	As-left Position	Name/date
1	PD-1V or ~~3V~~ JWB	Inboard port steam generator secondary side drain (closed)	closed	JWB 6/23/05
2	PD-2V or ~~4V~~ JWB	Outboard port steam generator secondary side drain (closed)	closed	JWB 6/23/05
3	PD-~~14V~~ JWB or 16V	Inboard stbd steam generator secondary side drain (closed)	closed	JWB 6/23/05
4	PD-~~15V~~ JWB or 17V	Outboard stbd steam generator secondary side drain (closed)	closed	JWB 6/23/05
5	HL-1V	Inboard high point vent isolation valve (closed)	closed	JWB 6/23/05
6	HL-2V	Outboard high point vent isolation valve (closed)	closed	JWB 6/23/05
7	PD-9-1	Aft cold leg drain line inboard isolation valve (closed)	closed	JWB 6/23/05
8	PD-9-2	Aft cold leg drain line outboard isolation valve (closed)	closed	JWB 6/22/05
9	PS-4V	Aft primary loop cold leg isolation valve (open)	OPEN	JWB 6/21/05
10	PS-6V	Forward primary loop cold leg isolation valve (open)	OPEN	JWB 6/21/05
11	PS-3V	Aft primary loop hot leg isolation valve (open)	OPEN	JWB 6/21/05
12	PS-5V	Forward primary loop hot leg isolation valve (open)	OPEN	JWB 6/21/05
13	DK-26V	Hot leg inboard isolation valve to emergency canned pump (closed)	closed	JWB 6/21/05
14	DK-21V	Hot leg outboard isolation valve to emergency canned pump (closed)	closed	JWB 6/21/05

JWB = John W. Bowen